Beyond Band Termination: Ultra-high spin spectroscopy studies of ^{159,160,161}Er

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How nuclei generate angular momentum at very high spins is still a topic of debate amongst nuclear spectroscopists. Recent observations of high-energy γ rays beyond the band terminating states in ^{157,158}Er [1] have suggested a return to collectivity at ultra-high ($50 - 60\hbar$) spin. Further analysis of this data set has shown similar structures in the lighter isotone, ^{156}Er. The light erbium nuclei can be thought of as valence nucleons coupled to a semi-magic ^{146}Gd$_{82}$ core. For ^{156}Er, it is easy to see how as the valence nucleons align with the core, the collective behaviour of the nucleus breaks down and a single-particle structure is observed. As more nucleons are added into this system, the observation of collective behaviour extends to higher and higher spins, and the probability of abruptly terminating states occurring is reduced.

A recent experiment has been performed at Argonne National Laboratory to look for such structures in ^{159,160,161}Er through fusion-evaporation reactions. A 215-MeV beam of ^{48}Ca was incident on a ^{116}Cd target, and the resulting γ rays were detected using the Gammasphere spectrometer. The data has since been unfolded into triple (γ^3) and quadruple (γ^4) coincidences and replayed into cubes (3D) and hypercubes (4D) for offline analysis, as well as higher-fold (γ^5 and above) analysis to elucidate higher-spin transitions. Several weak, high-energy γ rays have been observed in ^{159,160}Er and the evolution of favoured, band terminating states across the light erbium nuclei will be shown. A series of weakly populated rotational bands that appear to bypass the terminating states have also been observed in these nuclei [2,3]. The structures are thought to be stable triaxial strongly deformed bands, based on cranking calculations. The extended high-spin level schemes for ^{159,160,161}Er will be discussed in the context of that of the lighter Er isotopes and neighbouring nuclei, contrasting the transitional nature of ^{156}Er against the highly collective ^{161}Er.

[1] A. O. Evans *et al.,* Phys. Rev. Lett. **92**, 252502 (2004).
[2] J. Ollier *et. al,* to be published.
[3] E. S. Paul *et al.,* Phys. Rev. Lett. 98, 012501 (2007).